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PHYTOTOXICOLOGY SOIL AND FORAGE SURVEY OF THE LONDON MOE PCB STORAGE VAULTS 1989

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Background

The MOE maintains a series of engineered landfill vaults in London which were constructed specifically for the storage of solid material contaminated with PCBs. There are four vaults, identified by the year in which they were constructed (1984 to 1987). The cover of each vault was seeded with forage species to control erosion of the topsoil and fill, which was used overtop of the plastic and compacted clay liner. The four vaults cover approximately 11 acres. The London MOE office can arrange for local farmers to crop the hay on the vaults. The Phytotoxicology survey was requested to determine the contamination status of the hay cover.

Phytotoxicology Survey

On June 28, 1989 the author met with Dick Frier (MOE London) at the PCB storage facility. At the time of the investigation a hay crop was well established on the site, although it was spotty on the top of the 1987 vault.

Forage and soil were collected from three locations on each of the four vaults; the toe of the vault slope on the north and south sides, and the level area on the vault top. Single soil samples were collected from these areas using the standard Phytotoxicology collection protocol for organic samples. Single samples of forage were also collected adjacent to the soil sample sites. The single forage and soil samples were submitted to the MOE Trace Organics laboratory for analysis of total PCBs. In addition to the single samples for organic analysis, triplicate samples of forage were collected from the same sample sites and submitted to the Inorganic Trace Contaminants laboratory for analysis of 17 inorganic elements. The PCB analyses were conducted on a fresh weight basis, whereas the inorganic analyses were conducted on oven dried samples.

Results of PCB Analyses

The results of the soil PCB analyses are summarized in Table 1. A single result is listed for the north toe, the south toe, and the top centre of each of the four vaults, identified by their construction year. PCBs were detected in the soil at all sample sites, except the south toe of the 1987 vault. The other two sample sites on the 1987 vault had soil PCB concentrations of 0.23 ppm. The 1984 vault had soil PCB concentrations which ranged from 0.35 ppm on the north toe to 0.85 ppm on the vault top. Soil PCB contamination was marginally higher on the 1985 vault, where concentrations ranged from 0.19 ppm to 2.04 ppm. The 1986 vault had the highest soil PCB concentrations. The soil on the centre top of this vault contained 1.75 ppm, compared to 2.33 ppm on the north toe and 8.0 ppm on the south toe.

The MOE has a current landfill guideline of 50 ppm PCB; that is, soil containing more than 50 ppm cannot be disposed of in a municipal landfill. Soil containing less than 50 ppm PCB may be disposed of in a municipal landfill, but it is required to pass Regulation 309 leachate tests. The Canadian Council of Resource and Environment Ministers adopted a series of interim national soil PCB guidelines in September 1987. These guidelines are:

0.5 ppm - agricultural soil, including home gardens,
5 ppm - non-agricultural soil, including residential and general public access areas.

None of the vaults had soil PCB concentrations that exceeded the landfill guideline. However, soil from the 1984, 1985, and 1986 vaults exceeded the interim guideline for agricultural soil and, the 1986 vault exceeded the non-agricultural soil interim guideline.

The interim PCB guideline for agricultural soil was set quite low at 0.5 ppm on the rationale that grazing animals may ingest some soil with their forage and this could result in milk contamination. It is also intended to minimize the possibility of PCB uptake by crops.

None of the forage samples, collected from the same sites on each vault, contained PCBs. The analytical detection limit was 0.02 ppm. Therefore, even though the soil from all four vaults was contaminated with PCBs, uptake into the forage crop has not occurred. Based on the PCB analysis, there is no restriction to the use of the forage crop (i.e., it can be harvested for use by the local farming community).

Results of Forage Inorganic Analyses

Table 2 summarizes the results of the forage inorganic analyses. The data in the table are the mean of three separate samples and analyses. On the right side of the table is the Phytotoxicology Upper Limit of Normal (ULN) guideline for forage. The ULN represents, literally, the upper end of the normal range for the various inorganic elements in forage in Ontario. Statistically, the ULN is composed of the mean plus three standard deviations of background (control) forage samples, and therefore represents 99.9% of the sample population. Concentrations above the ULN are an indication that the forage has been exposed to a pollution source. ULNs are not available for all elements listed in Table 2, either because too little control data exist, or the background range is too large.

The ULN for Cu was exceeded in forage collected from the centre top and the south toe of the 1984 vault, the same two locations of the 1985 vault, and the centre top of the 1986 vault. The highest Cu concentration was 11 ppm, which exceeded the ULN of 7 ppm. Two forage sample sites, the centre top of the 1985 vault (56 ppm) and the north toe of the 1986 vault (73 ppm), also exceeded the manganese ULN of 50 ppm. The concentrations of most of the remaining 15 elements were at or below their respective analytical detection limits.

Table 3 compares the maximum forage concentrations detected from the four storage vaults with dietary toxic or maximum mineral tolerance levels for domestic animals. The table illustrates that even though the ULN was exceeded for Cu and Mn, these exceedances were still well below the tolerance level of agricultural animals. Therefore, there is no restriction on the use of the forage crop as a supplemental feed for animals in the local agricultural community.

Conclusions

PCBs were detected in soil at almost all locations across the four storage vaults. The storage vaults are engineered facilities designed specifically to prevent leaching of the contaminated PCB wastes from the containment cells. Although it is possible that leaching has occurred, it is more likely that the source of the PCBs detected in the soil on the top and sides of the vaults was re-entrainment of fugitive contamination. Highly contaminated solid wastes inventoried and transported around the London MOE storage site and eventually deposited in the vaults could have created an opportunity for fugitive emissions to marginally contaminate the soil in the immediate vicinity. The marginally contaminated on-site soil could be re-entrained to the area on and about the vaults through wind, surface water movement, or vehicles.

Regardless of the origin of the low level PCB soil contamination, the covering forage crop has not been affected. PCBs were not detected in the forage, and all the inorganic concentrations were well below the tolerance levels for domestic animals. Therefore, there is no reason that the forage cover on the storage vaults cannot be cropped by the local agricultural community for use as a supplemental feed source.

Table 1
Soil PCB Concentrations at the London
MOE PCB Storage Vaults

Vault and Location	PCB Concentration*
1984 Vault	
North Toe	0.35
Centre Top	0.85
South Toe	0.45
1985 Vault	
North Toe	1.02
Centre Top	0.19
South Toe	2.04
1986 Vault	
North Toe	2.33
Centre Top	1.75
South Toe	8.00
1987 Vault	
North Toe	0.23
Centre Top	0.23
South Toe	ND

ND - not detected (<0.02)
* ppm, single samples

Table 2
Results of Forage Inorganic Analyses at the London MOE PCB Storage Vaults

	Concentration												
	1984 Vault			1985 Vault			1986 Vault			1987 Vault			ULN
	NT	CT	ST	NT	CT	ST	NT	CT	ST	NT	CT	ST	
Cu	6.1	*8.8*	*7.5*	4.5	*11*	*9.7*	3.8	*7.2*	5.8	4.3	4.6	5.7	7
Ni	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	5
Pb	1.7	2.5	1.6	1.2	1.7	1.6	0.7	1.3	0.8	1.0	1.1	0.9	20
Zn	13	20	13	11	19	13	12	13	10	19	12	15	40
Fe	42	46	46	26	56	47	34	36	26	85	75	64	500
Mn	25	22	33	31	33	*56*	*73*	23	33	49	33	37	50
Al	18	18	23	9	23	23	18	15	8	58	54	40	NE
As	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	NE
Cd	<0.10	<0.10	<0.10	0.12	<0.10	<0.10	<0.10	<0.10	0.14	<0.10	<0.10	<0.10	0.5
Co	<0.20	0.30	0.30	<0.20	<0.20	<0.20	<0.20	<0.20	0.30	<0.30	<0.30	<0.30	2
Cr	<0.5	0.6	0.7	<0.5	0.7	<0.5	<0.5	0.6	<0.5	0.6	0.7	<0.5	5
Mo	0.6	0.7	0.4	1.2	4.0	1.3	1.1	0.9	0.9	1.9	1.9	1.4	6
Na	9	13	17	19	20	13	85	8	50	67	56	100	NE
Sb	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	NE
Se	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.5
Sr	7.6	8.6	9.2	6.7	26	10	7.6	6.5	7.5	9.4	9.0	7.4	NE
V	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	6

All data are ppm, mean of triplicate samples/analyses, oven dry weight
ULN - Upper Limit of Normal Guideline
NE - ULN guideline not established
NT - North Toe of Vault
CT - Centre of Top of Vault
ST - South Toe of Vault

Table 3
Comparison of ULN, Diet Tolerance Levels of Domestic Animals[1], and Inorganic Concentrations in Forage at the London MOE PCB Storage Vaults

Element	Concentration in ppm			Most Sensitive Animal
	ULN	Diet Toxic Level	Max. Level Found[2]	
Cu	7	250	11	cattle
Ni	5	700	0.7	poultry
Pb	20	100	2.5	horse/cattle/sheep
Zn	40	2000	20	sheep
Fe	500	2000	85	poultry
Mn	50	1000	73	sheep
Al	NE	200[4]	58	swine
As	NE	100	<0.2	poultry
Cd	0.5	50	0.14	all
Co	2	20	0.3	cattle
Cr	5	1000[4]	0.7	all
Mo	6	5	4	cattle
Na[3]	NE	20000[4]	85	poultry
Sb	NE	70[4]	<0.2	rabbit
Se	0.5	5	<0.2	cattle
Sr	NE	2000[4]	10	all
V	6	100	<0.5	poultry

1 - Animals include cattle, sheep, swine, poultry, horse and rabbit. Data are for animals with the lowest diet tolerance. Data from *Veterinary Trace Mineral Deficiency and Toxicity Information*, Agriculture Canada/B.C. Ministry of Agriculture, Publication 5139, 1981.

2 - Maximum level found at the MOE PCB Storage Vaults.

3 - Na as NaCl.

4 - No Diet Toxic Level available, data are Maximum Mineral Tolerance Levels from *Mineral Tolerance of Domestic Animals*, National Academy of Science, 1980.

ULN - Upper Limit of Normal.

NE - ULN not established.